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<p>(21) International Application Number: <b>PCT/US85/00188</b> (22) International Filing Date: <b>8 February 1985 (08.02.85)</b> (31) Priority Application Number: <b>578,861</b> (32) Priority Date: <b>10 February 1984 (10.02.84)</b> (33) Priority Country: <b>US</b> (71) Applicant: <b>FEDERAL-MOGUL CORPORATION</b> [US/US]; 26555 N.W. Highway, Southfield, MI 48034 (US). (72) Inventors: <b>PICHLER, Gerald, T. ; 1620 Robindale, Dearborn, MI 48128 (US). NASH, Stephen, E. ; 29216 Greening Blvd., Farmington Hills, MI 48018 (US). BROOKS, David, R. ; 4550 Curtis Road, Milford, MI 48042 (US).</b></p>		<p>(74) Agent: <b>STREIT, Richard, J.; Ladas &amp; Parry, 104 S. Michigan Avenue, Chicago, IL 60603 (US).</b>  (81) Designated States: <b>AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</b>  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: <b>UNITIZED DUAL-LIP SHAFT SEAL</b></p> <p>(57) Abstract</p> <p>A unitized grease seal (10). The seal member has a one-piece metal case (15), a molded elastomeric member (16) bonded to the metal case (15) and providing a series of spaced-apart inwardly extending retaining portions (38). The elastomeric member (16) also has two diverging lip portions (40-41) with a cavity (44) between them, one providing a grease retention lip (40) having small spaced-apart shallow indentations (43) enabling passage of small amounts of grease into the cavity (44), the other lip (41) portion having a polytetrafluoroethylene insert (17) bonded thereto. A one-piece metal wear sleeve member (12) has a shaft-engaging cylindrical portion (52) engaged by the lips (40-41) and a radially outwardly extending flange (57) with an axially inturned portion (58) having an outer portion (59) spaced radially inwardly from the outer generally cylindrical portion of the elastomeric member (16) but extending radially outwardly beyond the radially inner extremities of the retaining portions (38). During assembly, the wear sleeve flange's inturned portion (58) is snapped into the space between the retaining portions (38) and the case's radial flange (30).</p>		

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1 Unitized dual-lip shaft seal

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S P E C I F I C A T I O N

4

5 This invention relates to an improved dual-lip  
6 grease-retaining and dirt-excluding shaft seal.

7

8 Background of the Invention

9 With customers demanding ever increasing quality  
10 and long life, automobile manufacturers have, in turn  
11 demanded more from the manufacturers of shaft seals. Some  
12 seals of the present invention are intended to be used on  
13 wheel spindles of automobiles, and to last without  
14 replacement for as long as 100,000 miles, while retaining  
15 the grease and excluding grit, dirt, corroding liquids,  
16 and so on. The seals heretofore made have not had so long  
17 a life. Moreover, the seal is required to be installable  
18 in a very small space.

19 Exclusion of deleterious foreign matter is even  
20 more important than the retention of the grease, as in  
21 certain applications grease may be added to the wheel  
22 bearings from time to time; in fact, it is desirable to  
23 have some grease flow out from the grease retaining seal  
24 lip into the space between the grease-retaining lip and  
25 the dirt-excluding lip, so as to lubricate both lips. It  
26 is not even harmful to have a small amount of grease  
27 expelled via the dirt-excluding lip during lubrication of  
28 the wheel bearings. However, the amount allowed to pass  
29 the grease-retaining lip should be kept very small.

30 In any event, there tends to be more wear at the  
31 dirt-excluding lip; because that lip is quite likely to  
32 come into contact with dirt, grit, dust and corroding  
33 liquids. It is also desirable to fling the outside foreign  
34 matter outwardly in such a way that it tends not to work  
35 its way to the dirt-excluding lip, but even with such

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1 flinging, there will still be a substantial amount of  
2 deleterious foreign matter attempting to pass by the lip  
3 over a period of driving an automobile 100,000 miles.

4 U.S. Patents Nos. 4,399,998 and 4,344,631 show  
5 some venting structure for seal lips, as does U.S. Patent  
6 2,830,832, but none of these vents are suitable for use in  
7 the present seal.

8 It is also important that the seal be unitized,  
9 because with a precision product of this kind and of this  
10 size, wrong or careless installation can immediately ruin  
11 the sealing lips and lead to the manufacturer's having to  
12 make good his guarantee on the wheel bearings. Assembly-  
13 line workers in automobile plants are often careless, and  
14 even though they may try to be careful, separate installa-  
15 tion of a seal and then of a dirt flinging member or of a  
16 wear sleeve to go upon the shaft tends to produce mis-  
17 alignments which considerably shorten the life of the  
18 seal, and may in fact cause its ruin within a few miles of  
19 the running of the new car.

20 There are many unitized seal structures, including  
21 those shown in U.S. Patents Nos. 3,021,161; 3,108,815;  
22 3,179,424; 3,685,841; 3,561,770; 4,028,057; and 4,285,526,  
23 but few, if any, are applicable to a seal as narrow as  
24 that of the present invention. Some of the enumerated  
25 patents show dual-lip seals, but none like those of the  
26 present invention.

27 To insure long life at the dirt exclusion seal, a  
28 very long lasting seal composition is desirable. It is  
29 possible to make a seal having many of the features of the  
30 present invention by using only a standard high quality  
31 elastomer such as acrylic rubber, butyl rubber, or an  
32 ethylene acrylic rubber (e.g., Vamac® , a DuPont® Reg.  
33 Trademark). However, the use of polytetrafluoroethylene,  
34 or an equivalent material, at the actual sealing edges is  
35 highly desirable. The incorporation of polytetrafluoro-  
36 ethylene becomes important due to the fact that the  
37 temperature of the seal during use may rise to between  
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1 300 and 350°F. Also the pressure from the grease side of  
2 the seal may rise to the range of 50 to 60 p.s.i. at up to  
3 about 1200 rpm, which corresponds to vehicle speeds of 80  
4 to 90 miles per hour. Polytetrafluoroethylene also  
5 reduces the torque of the seal on the wear sleeve.

6 Since polytetrafluoroethylene cannot be readily  
7 and economically molded to complex shapes, it usually must  
8 be incorporated into the seal by using a wafer-like  
9 washer, as by bonding it to an elastomeric supporting  
10 member. The present invention does this in novel manner  
11 employing a novel method of manufacture to produce a  
12 novel product. The method further, includes features in  
13 addition to the incorporation of the polytetrafluoro-  
14 ethylene.

15 Polytetrafluoroethylene is shown bonded to elasto-  
16 mers in shaft seals in many patents, including U.S.  
17 Patents Nos. 3,495,843 and 4,239,243 and East German  
18 Patent No. 328,815, but, again the structure of the  
19 present invention and the method of producing it do not  
20 appear to be known.

21

## 22 Summary of the Invention

23 The product of this invention is a unitized grease  
24 seal and comprises a dual-lip seal member and a wear-  
25 sleeve member attached together, preferably releasably.

26 The seal member comprises a one-piece metal case,  
27 a molded elastomeric member bonded to the metal case, and  
28 a polytetrafluoroethylene lip member bonded to the elasto-  
29 meric member and providing the dirt-excluding sealing lip.

30 The case has a cylindrical outer portion defining  
31 a wall with an outer surface adapted to be press fitted  
32 into a stationary bore. If desired, part of the outer  
33 surface may be covered with elastomer, and this elastomer  
34 may be a portion of the elastomeric member. A reverse  
35 cylindrical portion extends back from one end of the outer  
36 wall and has an outer surface bearing against the inner  
37 surface of that wall. The reverse portion is much shorter

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1 than the outer portion, and from its inner end, a radial  
2 flange extends inwardly to a radially inner end. The  
3 flange has an outer face on the air side of the seal,  
4 continuous with the inner face of the reverse portion.

5         The molded elastomeric member is bonded to the  
6 metal case. Thus, a radially extending portion of the  
7 elastomeric member is bonded to the outer face of the  
8 radial flange, and an outer generally cylindrical portion  
9 is bonded to the inner surface of the reverse portion.  
10 This generally elastomeric cylindrical outer portion has a  
11 series of radially inwardly extending wear-sleeve-  
12 retaining portions spaced circumferentially from each  
13 other. An inner portion of the elastomeric member extends  
14 inwardly of the radially inner end of the case's radial  
15 flange, being bonded thereto, and has two diverging lip  
16 portions, meeting, as molded, at about 90° at a point  
17 spaced radially in from the inner end of the case, and  
18 there is a cavity in between these lip portions. One of  
19 these lip portions is on the grease side of the seal, and  
20 it has a grease-retention lip provided with a series of  
21 spaced-apart small relieved indentations enabling passage  
22 of small amounts of grease into the cavity. The other lip  
23 portion provides a dirt-excluding lip portion. Preferably,  
24 it has a cylindrically extending recess therein, and a  
25 polytetrafluoroethylene sealing lip member fits into the  
26 recess and is bonded to the elastomeric member. This poly-  
27 tetrafluoroethylene lip preferably provides the sealing  
28 edge portion of that lip portion.

29         In addition to the seal member, there is a one-  
30 piece metal wear sleeve and deflector member having a  
31 radially inner, cylindrical, wear sleeve portion with an  
32 inner surface adapted to be press fitted on a rotatable  
33 shaft and an outer surface engaged by both of the sealing  
34 lips. The outer diameter of this cylindrical portion is  
35 greater than that of the as-made inner diameter of the  
36 sealing lips, so that assembly of the wear sleeve on the  
37 seal member causes further spreading-apart of the two

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1 lips. The dirt-excluding lip, when in position on the wear  
2 sleeve, has an end wall on its air side that is substan-  
3 tially perpendicular to the wear sleeve's outer surface,  
4 or as nearly perpendicular as is practical.

5       The wear sleeve member also has a unitizing  
6 radially outwardly extending flange portion serving as a  
7 deflector and slinger to protect the dirt-excluding lip  
8 from much of the foreign matter that otherwise come into  
9 contact with that lip. It also helps to unitize the  
10 assembly. Preferably it first extends radially outwardly  
11 from the air-side end of the wear sleeve's cylindrical  
12 portion and then turns in toward the radial flange of the  
13 case. Near or at its outer end, a portion is spaced  
14 inwardly from the outer, generally cylindrical portion of  
15 the elastomeric member but extends outwardly beyond the  
16 radially inner extremities of the elastomeric retaining  
17 portions, so that this deflector portion of the wear  
18 sleeve member can be snapped into the space between the  
19 elastomeric retaining portions and the elastomer-coated  
20 radial flange of the metal case.

21       The invention also includes a method for making  
22 the unitized dual-lip shaft seal.

23       It may begin by seating on a first mold member the  
24 one-piece metal case, its outer bore-engaging cylindrical  
25 portion being seated against a second mold member, appro-  
26 priate parts of the case being covered with elastomer-  
27 bonding cement. A third mold member is engaged with the  
28 first mold member so as to define between them a cavity  
29 for molding to finished size and shape the grease-facing  
30 lip, at an angle of about 45° to the radial flange. The  
31 third mold member is also shaped to provide a series of  
32 projections in the cavity that provide the spaced-apart  
33 indentations in the grease-retaining lip. This third mold  
34 member also provides one surface of the cavity for the  
35 dirt-excluding lip, this surface sloping in the opposite  
36 direction from the grease-lip cavity, at an angle of  
37 about 45° to the radial flange, so that the two cavities

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1 meet at about 90°. The sloping surface leads to a ledge  
2 spaced away from the radial flange and parallel to the  
3 plane thereof; the ledge ends at an inner cylindrical  
4 boundary.

5         A flat washer of polytetrafluoroethylene is placed  
6 on the ledge with the inner circumference of the washer  
7 engaging the boundary and the outer circumference extend-  
8 ing beyond the ledge and overhanging a portion only of the  
9 sloping surface. Appropriate surface portions of the  
10 washer are treated beforehand, as by acid etching and then  
11 with bonding cement, to enhance the bonding of elastomer  
12 thereto.

13         A ring of uncured elastomer ("prep") is placed on  
14 top of the portion of the polytetrafluoroethylene washer  
15 supported by the ledge, and a fourth mold member is  
16 brought toward and against the second and third mold  
17 members to close the mold, all of the mold members being  
18 heated to a molding and curing temperature. Closing the  
19 mold defines the remainder of the mold cavity for the  
20 dirt-excluding lip and defines a further cavity for the  
21 radial portion next to said radial flange and the outer  
22 cylindrical portion of the elastomeric member. This outer  
23 cylindrical portion of the mold is shaped to provide a set  
24 of circumferentially spaced apart cavity portions extend-  
25 ing radially inwardly to provide the wear-sleeve retention  
26 members. The movement of the fourth mold member simulta-  
27 neously forces the elastomer to flow into all the mold  
28 cavities and also to flex the overhanging portion of the  
29 polytetrafluoroethylene washer into engagement with the  
30 sloping mold surface and to initiate bonding of the  
31 elastomer to the case and to the washer.

32         The elastomer is then cured under heat and  
33 pressure to a desired cure, so that it holds its shape and  
34 completes the bonding of the elastomer to the case and the  
35 washer. Thereby, it produces the shaft sealing member,  
36 which has a grease-retaining lip molded to its final shape  
37 and a dirt-excluding lip, which at that time has a portion  
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1 extending generally inwardly therefrom; the shaft sealing  
2 member also has its molded set of wear-sleeve retention  
3 members spaced away from the case's radial flange. The  
4 mold is then opened and the shaft sealing member removed.

5         Next, the dirt-excluding lip is trimmed to a  
6 desired length, the edge being trimmed at a desired angle  
7 so that when the seal is unitized and the lips are spread  
8 apart, the trimmed edge is nearly parallel to the case's  
9 radial flange.

10         In addition, a one-piece metal wear sleeve is  
11 formed with a cylindrical portion for engagement with both  
12 sealing lips and of a diameter to spread apart those lips  
13 and, as a result, to move the trimmed edge to its afore-  
14 mentioned nearly-parallel position. The wear sleeve also  
15 has a shaped radially outwardly extending deflecting  
16 portion, of a size enabling unitization.

17         Then, the wear sleeve and shaft sealing member are  
18 assembled together. The sleeve's radially outwardly  
19 extending portion is placed on the air side of the shaft  
20 sealing member, and the lips are placed in engagement with  
21 the cylindrical portion of the wear sleeve. The radially  
22 outwardly extending portion is then snapped into the space  
23 between the elastomeric retention members and the  
24 elastomer-covered radial flange, so that the retention  
25 members thereafter hinder retraction of the wear sleeve  
26 from the shaft-sealing member, although it can, if  
27 desired, be taken off.

28

#### 29 Brief Description of the Drawings

30         Fig. 1 is a view in end elevation of a unitized  
31 dual-lip shaft seal embodying the principles of the  
32 invention.

33

34         Fig. 2 is a greatly enlarged view in section of  
35 one portion of the seal taken along the line 2-2 in  
36 Fig. 1.

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1           Fig. 3 is a further enlarged view in cross section  
2 of the shaft seal element alone shown in its as-molded and  
3 trimmed position.

4

5           Fig. 4 is a similarly enlarged view of the wear  
6 sleeve.

7

8           Fig. 5 is a view similar to Fig. 2 of a modified  
9 form of the invention employing a differently shaped wear  
10 sleeve and a modified form of the outer portion of the  
11 outer seal of Fig. 2.

12

13           Fig. 6 is a view in section of approximately half  
14 of the lower parts of a mold for molding the shaft seal,  
15 shown with the mold open and the case, the polytetra-  
16 fluoroethylene washer, and the raw elastomer placed in  
17 position.

18

19           Fig. 7 is a similar view of the mold in its closed  
20 position.

21

22           Fig. 8 is a fragmentary enlarged view in section  
23 of a portion of Fig. 7, showing the seal as molded and  
24 indicating the trim line.

25

26 Description of a Preferred Embodiment

27           As shown in Fig. 1 a unitized seal 10 of the  
28 invention is a continuous annular device. As shown in  
29 Figs. 1 and 2, the seal 10 comprises a sealing member 11,  
30 and a wear sleeve member 12, which are assembled together  
31 in a manner resulting in unitization, so that the seal is  
32 installed as a unitized assembly 10, rather than having  
33 separate installation of its two major components 11 and  
34 12.

35

36           The elastomeric seal member 11 preferably  
37 comprises three major elements which are best seen in Fig.  
38 3, which presents the as-molded and trimmed sealing member

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1 11. This member 11 comprises a metal case member 15, an  
2 elastomeric member 16 which is bonded to the case 15, and  
3 a polytetrafluoroethylene insert 17 which is bonded to the  
4 elastomeric member 16.

5       The case 15 is a unitary annular metal member  
6 shaped to provide a cylindrical outer portion 20 having  
7 an outer surface 21 for leak-tight engagement in the bore  
8 of a housing. The outer surface 21 is preferably coated  
9 with a suitable bore-locking material, not shown. One end  
10 22 of the portion 20 is free and the other end 23 is  
11 curved back on itself to provide a short inner cylindrical  
12 portion 24 with its outer surface 25 bearing against the  
13 inner periphery 26 of the portion 20. The portion 24 has  
14 an inner surface 27, and it is curved inwardly at its end  
15 28 to provide a radial flange 30 having an outer or air-  
16 side surface 31, an inner or grease-side surface 32, and  
17 a radially inner end 33. To this end 33 and to the inner  
18 portions of the surfaces 31 and 32 is bonded the elasto-  
19 meric sealing element 16. The actual molding will be  
20 described later, in conjunction with Figs. 6 and 7.

21       The elastomeric sealing element 16 may be of any  
22 suitable elastomer; it is a unitary member having a radi-  
23 ally extending portion 35 bonded to the surface 31 of the  
24 radial flange 30, and an outer cylindrical portion 36  
25 bonded to the surface 27 of the case 15. This cylindrical  
26 portion 36 is provided near its axial end 37 with a  
27 series, usually four, of inwardly directed projections 38  
28 which provide short retaining members for holding the wear  
29 sleeve member 12 in its unitized position.

30       The radially inner portion of the elastomeric  
31 member 16 comprises two lip portions 40 and 41. The lip  
32 portion 40 comprises an as-molded lip edge 42 which need  
33 not be trimmed and which faces at an angle of about 45°  
34 away from the radial flange 30 of the case 15. It serves  
35 as the grease-retaining lip 40. Its lip edge 42 may have  
36 a slight curvature and is preferably provided with a  
37 series, preferably three, of short lip vents 43, which  
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1 are equally spaced around the periphery, and may be, and  
2 preferably are, approximately 0.005" deep by 0.125" wide.  
3 The purpose of these vents 43 is to permit the entry of  
4 grease from the bearing chamber into a cavity 44 in  
5 between the two lips to keep the lips lubricated. The  
6 amount of grease desired there is relatively small, and  
7 therefore the vent passages 43 are quite small, so that  
8 they do not significantly interfere with grease  
9 retention.

10 The other sealing lip portion 41 is made consider-  
11 ably wider than the lip portion 40 to provide a good  
12 support for the polytetrafluoroethylene insert 17, which  
13 takes up approximately half the width of the lip portion  
14 41 and which must be bonded to and securely retained by  
15 the elastomeric lip portion 41. Thus, the elastomer itself  
16 may be considered as having converging walls 45 and 46 and  
17 a recess having walls 47 and 48. Into the recess and flush  
18 with the walls 47 and 48 is the polytetrafluoroethylene  
19 member 17. The lip portion 41 and the tetrafluoroethylene  
20 member 17 have a common trimmed edge 50 which is not  
21 perpendicular to the wall 45 but is, instead, so trimmed  
22 that when the sealing member 11 is assembled on the wear  
23 sleeve member 12, the trimmed edge 50 will approach as  
24 closely as possible a right angle to the wear sleeve, as  
25 can be seen in Fig. 2. The limiting factor here is what  
26 the shape and dimensions of the seal enable the trimming  
27 knife to do without cutting any of the other parts.  
28 Typically this means that trim lies at an angle of about  
29 30° to a plane parallel to the radial flange 30. The way  
30 in which the seal is made will be described later. In any  
31 event, the trimming results in an originally sharp sealing  
32 lip edge 51, what becomes blunted as the lip wears.

33 The wear sleeve member 12 is a formed metal  
34 member, preferably made from the kind of sheet steel  
35 usually used for this type of installation, typically  
36 treated with phosphoric acid or some similar solution.  
37 This member 12, as shown in Fig. 4, has a wear sleeve 52  
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1 proper, the inner periphery 53 of which fits snugly on a  
2 shaft, while its outer periphery 54 serves as the surface  
3 upon which the seal lips 42 and 51 run, as can be seen in  
4 Fig. 2. One end 55 facing the bearing is a free end, while  
5 at the other end 56 the wear sleeve member 12 is curved  
6 outwardly to provide a radially extending portion 57  
7 followed by an angularly extending portion 58 that goes  
8 back in axially, toward the opposite end 55, terminating  
9 at an end 59. The ends 55 and 59 are cut off before the  
10 forming. The angular portion 58 is shown extending at an  
11 angle of about  $45^{\circ}$  to the radial portion 57, and the end  
12 59 lies out beyond the projections 38 but spaced out from  
13 the inner surface of the cylindrical portion 36. Thus, the  
14 outer periphery 59 can be snapped into the four or more  
15 protuberances or retaining members 38 to unitize the seal  
16 10. The spacing apart of the members 38 and the flexi-  
17 bility of the elastomer make assembly a very simple  
18 matter.

19       When the members 11 and 12 are assembled to  
20 complete the seal 10 (Fig. 2) the two lips 42 and 51 are  
21 spread apart more widely than before (Fig. 3), and the  
22 cavity 44 between them is somewhat reduced in height, but  
23 is spread in width. The recesses 43 for admitting grease  
24 into the cavity 44 are operative, and the polytetrafluoro-  
25 ethylene sealing member 17 has its axially outer edge 50  
26 substantially parallel to the radial portion 57 of the  
27 wear sleeve member 12, as well as to the radial flange 30  
28 of the seal case 15.

29       The portions 57 and 58 of the wear sleeve member  
30 12 act as a deflector and as a slinger, to free the seal  
31 as much as possible from water and corrosive liquids, as  
32 well as from dirt and dust.

33       To obtain somewhat better operation of this  
34 slinging-deflecting feature, the wear sleeve structure 60  
35 shown in Fig. 5 may be used, although it is more difficult  
36 to form and therefore somewhat more expensive. In this  
37 instance, after a short radial portion 61 at the end of  
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1 the wear sleeve proper 62, the metal has a portion 63  
2 bent inwardly axially toward the opposite end of the wear  
3 sleeve 62, at approximately 90° and then has a bent-out  
4 portion 64 lying parallel to the radial flange 30, when  
5 installed, and then a final portion 65 is bent back at an  
6 acute angle to bring its end 66 out within the inner  
7 diameter of the retention members 38. This bending back  
8 results in leaving axially inside the members 38 the part  
9 of the portion 65 which is of greater diameter than the  
10 retaining members 38, though of lesser diameter than the  
11 cylindrical surface 36 from which the retaining members 38  
12 project. This structure provides an improved slinging  
13 action, while taking up no more room. However, its practi-  
14 cality depends partly on the necessity for any greater  
15 slinging action, and on the additional costs involved.

16 As would probably be apparent anyway, the exterior  
17 part of the case 15 may be at least partially coated with  
18 elastomer, as is also shown in Fig. 5. Here, an outer  
19 portion 70 of the elastomer is formed to cover the  
20 exterior surface 71 of an inwardly stepped portion 72 of  
21 the case. The rubber coating 70, since it is able to  
22 accommodate itself to the bore diameter by some flow  
23 towards its end, is made a little larger in diameter than  
24 the remaining portion 73 of the bore-engaging portion of  
25 the metal case.

26 Going now to the method of manufacture of the  
27 seal, a preferred such method incorporates a four-piece  
28 mold 75 as shown in Figs. 6 and 7. The mold 75 is shown  
29 in a particular orientation which will be used for  
30 description, although a different orientation is possible.  
31 A stationary mold base 80 is shaped to provide a bottom  
32 planar surface 81 with an inner cylindrical surface 82 and  
33 an outer cylindrical surface 83. The inner cylindrical  
34 surface 82 leads up to a horizontal planar annular surface  
35 84, which, in turn, leads out to a short cylindrical  
36 surface 85, and then to an inclined frustoconical portion  
37 86. At the outer end of the portion 86 is a shelf 87

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1 connected by a step 88 to a short case-engaging planar  
2 rest 89. From there, a radius portion 90 leads to a  
3 cylindrical portion 91 terminating at a planar shoulder  
4 92. The outer edge of the shoulder 92 terminates at a  
5 frustoconical outer surface 93, at the lower end of which  
6 is a flash trap 94 followed by a planar shelf 95 leading  
7 to the outer cylindrical surface 83.

8           A second, outer, mold member 100 is placed partly  
9 around and partly upon the base mold member 80. It has an  
10 outer generally cylindrical surface 101 and a lower flat  
11 annular face 102 which engages the annular shelf 95. It  
12 also has a frustoconical surface 103 bearing against the  
13 frustoconical surface 93 of the first mold member 80.  
14 Above that is a short cylindrical portion 104 going up to  
15 another frustoconical surface 105 that leads to an upper  
16 planar face 106 extends out to its outer surface 101.

17           The metal case 15 is preferably placed with its  
18 outer surface 21 bearing against the cylindrical portion  
19 104 of the mold member 100 and with the surface 32 of its  
20 radial flange 30 resting upon the rest 89, while most of  
21 the inside surface 26 the case portion 15 is spaced away  
22 from the cylindrical portion 91.

23           A third, inner, mold member 110 has a stepped  
24 generally cylindrical inner through opening with a lower  
25 cylindrical surface 111, a step 112, and an upper cylin-  
26 drical surface 113. A mold pin 114 has a head 115 engaging  
27 the step 112 and forcing a lower annular face 116 of the  
28 mold member 110 snugly against the annular surface 84. A  
29 cylindrical face 117 engages the cylindrical surface 85,  
30 and a frustoconical surface 118 engages and overlies the  
31 frustoconical surface 86 of the first mold member 80.  
32 However, the upper and outer end of the surface 118 is  
33 shaped to provide a cavity 120 between the two mold  
34 members 80 and 110 adjacent to the shelf 87. The cavity  
35 120 provides the as-molded grease-retaining lip portion  
36 40. At its upper end, the cavity 120 is terminated, and a  
37 frustoconical portion 121 leads upwardly to an inwardly

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1 extending ledge 122. The ledge 122 then leads to a nearly  
2 cylindrical tapered portion 123 ending in an annular  
3 planar portion 124 which leads in to the inner periphery  
4 113.

5 A polytetrafluoroethylene washer 125, which  
6 preferably has been acid etched on one surface provided  
7 and then with a coating of bonding cement there and on its  
8 outer periphery 126, is placed on top of the ledge 122,  
9 with the etched and coated surface facing up and with its  
10 inner periphery 127 abutting the tapered portion 123. The  
11 washer 125 extends out beyond the ledge 122 and overhangs  
12 a portion of the frustoconical surface 121. Atop the  
13 washer 125, is placed a ring 128 of uncured elastomer  
14 calculated to provide the proper amount for filling the  
15 molded cavities provided for the elastomer.

16 A fourth or upper mold member 130 is attached to  
17 an upper mold pin 131 having a head 132 that partially  
18 compresses a series of springs 133 against a lower  
19 shoulder 134 of the member 130. Like the first mold member  
20 80, the member 130 has a flash receiving cavity 135 at the  
21 outer end of a planar lower face portion 136 and at the  
22 inner end of a tapered portion 137 that mates with the  
23 tapered portion 123 of the third mold member 110 when the  
24 mold 75 is in its closed position. At the lower end of the  
25 tapered portion 137 is a planar annular surface 138  
26 leading to a frustoconical portion 140, the surfaces 138  
27 and 140 defining part of the mold cavity for the dirt-  
28 excluding lip 41. The surface 140 is succeeded by a short  
29 radial portion 141 followed by a cylindrical step 142  
30 leading to a short annular planar surface 143, from the  
31 outer end of which a tapered portion 144 leads outwardly  
32 and upwardly. The tapered portion 144 mates with the  
33 tapered portion 105 of the second mold member 100 and has  
34 another flash-receiving cavity 145 at its outer end.  
35 Beyond that is a planar surface 146 that mates with the  
36 surface 106 of the second mold member 100 and leads to an  
37 outer cylindrical surface 147.

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- 15 -

1           When the heated mold is closed during the progress  
2 from the position shown in Fig. 6 to that of Fig. 7, the  
3 mold cavities are defined, and simultaneously the elastomer  
4 is caused to flow thereinto. If there is any excess  
5 elastomer it flows into the flash-receiving cavities 135  
6 and 145. This flash is relatively easily removed from the  
7 molded seal. However, no flash forms on the as-molded lip  
8 40. During this operation the elastomer and the fourth or  
9 upper mold member 130 act upon the polytetrafluoro-  
10 ethylene washer 125 to force its overhanging portion flush  
11 against the frustoconical surface 121 while bonding the  
12 elastomer to it. After the mold 75 is closed, it is held  
13 closed until cure of the elastomer has been completed, and  
14 then it is parted and the sealing member is ejected by  
15 conventional means.

16           As will be seen from the mold drawing, the inner  
17 portion of the polytetrafluoroethylene washer 125 and the  
18 elastomer there must be trimmed off. The trimming is along  
19 the line 150 in Fig. 8, leaving the edge 50 shown in Fig.  
20 3, so that the inner periphery of the lip edge 52 is  
21 smaller in diameter than that of the grease-retaining  
22 lip edge 51, the trimming being made, as stated before,  
23 at an angle of about 30° to the plane of the radial flange  
24 30 and, in any event, such that the surface 50 will become  
25 nearly a right angle when the seal is unitized.

26           The wear sleeve member 12 is made by conventional  
27 forming means to the desired shape, and is, as already  
28 been said, snapped into the oil seal member 11, so that  
29 the retaining members 38 thereafter hold it in place. The  
30 seal assembly 10 can, if actually need be, taken apart,  
31 but this is far from normal, and it is almost always left  
32 together. It will not come apart accidentally because of  
33 the retention members 38.

34  
35           To those skilled in the art to which this inven-  
36 tion relates, many changes in construction and widely  
37 differing embodiments and applications of the invention  
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- 16 -

1 will suggest themselves without departing from the spirit  
2 and scope of the invention. The disclosures and the  
3 descriptions herein are purely illustrative and are not  
4 intended to be in any sense limiting.

5           What is claimed is:

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1           1. A unitized grease seal, including in  
2 combination:

3           a seal member having

4           a one-piece metal case having a cylindrical bore-  
5 sealing portion with an inner surface and an inwardly  
6 extending radial flange, in between the ends of said bore-  
7 sealing portion, having a radially inner end, an air-side  
8 radial surface, and an opposite grease-side radial  
9 surface,

10          a molded elastomeric member bonded to said metal  
11 case and having a radially extending portion bonded to  
12 said air-side radial surface, an outer generally cylin-  
13 drical portion bonded to said inner surface of the bore-  
14 sealing portion on the air side of said flange and  
15 providing a series of radially inwardly extending retain-  
16 ing portions spaced circumferentially from each other,  
17 and

18          said elastomeric member also having an inner  
19 portion extending radially inwardly of said inner end of  
20 said radial flange and having two diverging lip portions  
21 with a cavity between them, one said lip portion providing  
22 a grease retention lip having small spaced-apart shallow  
23 indentations enabling passage of small amounts of grease  
24 into said cavity, the other said lip portion having a  
25 polytetrafluoroethylene insert bonded to said elastomeric  
26 member and providing the sealing edge portion of a dirt-  
27 excluding lip, and

28          a one-piece metal wear sleeve member having a  
29 radially inner shaft-engaging cylindrical portion having  
30 an outer surface engaged by said lips and having a larger  
31 outer diameter than the free-standing inner diameter of  
32 said lips, so that assembly of the wear sleeve on the seal  
33 member causes further spreading-apart of said two lips,  
34 said dirt-excluding lip when in position on said wear  
35 sleeve having an end wall on its air side that is sub-  
36 stantially perpendicular to said wear sleeve's outer  
37 surface,

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1           said wear sleeve member also having a radially  
2 outwardly extending flange on its air-side end, with an  
3 axially inturned portion having an outer portion spaced  
4 radially inwardly from the outer generally cylindrical  
5 portion of said elastomeric member but extending radially  
6 outwardly beyond the radially inner extremities of said  
7 retaining portions, so that during assembly, the wear  
8 sleeve flange's inturned portion can be snapped into the  
9 axially extending space between said retaining portions  
10 and the elastomer-covered radial flange.

11

12           2. The grease seal of claim 1 wherein said wear  
13 sleeve's flange has a truly radial portion where it meets  
14 said cylindrical wear sleeve portion, extending beyond  
15 said end wall of said dirt-excluding lip followed by an  
16 angularly extending portion, going toward said case's  
17 radial flange and ending at its radially outermost,  
18 axially innermost point.

19

20           3. The grease seal of claim 1 wherein said wear  
21 sleeve's flange has a truly radial portion where it meets  
22 the wear sleeve's cylindrical portion, extending beyond  
23 said dirt-excluding, lip followed by an axially inwardly  
24 extending portion going toward said case's radial flange,  
25 followed by a radially extending portion parallel to said  
26 case's radial flange and extending out radially beyond  
27 said retaining portions, followed by an axially outwardly  
28 and radially inwardly extending angular portion ending  
29 substantially flush axially with the end of said bore-  
30 sealing portion and radially within said retainer  
31 portions.

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1           4. A unitized dual-lip grease seal, including in  
2 combination:

3           a seal member having

4           a one-piece metal case with a cylindrical bore-  
5 sealing portion having an inner surface and an inwardly  
6 extending radial flange, in between the ends of said bore-  
7 sealing portion, having a radially inner end, an air-side  
8 radial surface and an opposite grease-side radial  
9 surface,

10          a molded elastomeric member bonded to said metal  
11 case and having a radially extending portion bonded to and  
12 completely covering said air-side radial surface, an  
13 outer generally cylindrical portion bonded to and covering  
14 that portion of said inner surface of the bore sealing  
15 portion which lies on the air side of said flange and  
16 providing a series of radially inwardly extending retain-  
17 ing portions spaced circumferentially from each other,

18          said elastomeric member also having an inner  
19 portion extending radially inwardly of said inner end and  
20 bonded thereto and having two diverging lip portions,  
21 meeting, as molded, at about 90° at a point spaced  
22 radially in from said inner end and with a cavity between  
23 them, one said lip portion providing a grease retention  
24 lip and the other dirt-excluding lip, and

25          a one-piece metal wear sleeve member having a  
26 radially inner shaft-engaging cylindrical portion having  
27 an outer surface engaged by said lips and having a larger  
28 outer diameter than the free-standing inner diameter of  
29 said lips, so that assembly of the wear sleeve on the seal  
30 member causes further spreading-apart of said two lips,  
31 said dirt-excluding lip when in position on said wear  
32 sleeve having an end wall on its air side that is sub-  
33 stantially perpendicular to said wear sleeve's outer  
34 surface,

35          said wear sleeve member also having a radially  
36 outwardly extending flange on its air side end, with an  
37 axially inturned portion having a radially outermost

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1 portion spaced inwardly from the outer generally cylin-  
2 drical portion of said elastomeric member but extending  
3 radially outwardly beyond the radially inner extremities  
4 of said retaining portions, so that, during assembly, the  
5 wear sleeve flange's intumed portion can be snapped into  
6 the space between said retaining portions and the  
7 elastomer-covered radial flange.

8

9 5. The grease seal of claim 4 wherein said grease-  
10 retaining lip is provided with spaced-apart shallow  
11 indentations.

12

13 6. The grease seal of claim 4 wherein said dirt-  
14 excluding lip has a polytetrafluoroethylene insert bonded  
15 thereto and providing the sealing edge.

16

17 7. A unitized grease seal, including in  
18 combination:

19 a seal member having

20 a one-piece metal case with a cylindrical outer  
21 portion defining a wall with an outer surface adapted to  
22 be press-fitted into a stationary bore and an inner  
23 surface, a reverse cylindrical portion extending back from  
24 one end of said wall and having an outer surface bearing  
25 against said inner wall surface and an inner surface, said  
26 reverse portion being much shorter than said outer  
27 portion, and an inwardly extending radial flange leading  
28 from the axially inner end of said reverse portion and  
29 having a radially inner end, an outer face on the air side  
30 of said seal and continuous with the inner face of said  
31 reverse portion, and an opposite inner face on the grease  
32 side of said seal,

33 a molded elastomeric member bonded to said metal  
34 case and having a radially extending portion bonded to and  
35 covering said outer face of said radial flange, an outer  
36 generally cylindrical portion bonded to and covering the

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1 inner surface of said reverse portion and providing a  
2 series of radially inwardly extending retaining portions  
3 spaced circumferentially from each other,

4       said elastomeric member also having an inner  
5 portion extending radially inwardly of said radially inner  
6 end of said radial flange and bonded thereto and having  
7 two diverging lip portions, meeting, as molded, at about  
8 90° at a point spaced radially in from said inner end and  
9 with a cavity between them, one said lip portion being on  
10 the grease side of the seal and having a grease-retention  
11 lip provided with a series of spaced-apart shallow  
12 indentations enabling passage of small amounts of grease  
13 into said cavity, the other said lip portion providing a  
14 dirt-excluding lip portion having a cylindrically extend-  
15 ing recess therein, and

16       a polytetrafluoroethylene sealing lip member  
17 fitting in said recess and bonded to said elastomeric  
18 member and providing the sealing edge portion of said dirt  
19 excluding lip, said lip having an end wall on its air  
20 side,

21       a one-piece metal wear sleeve member having a  
22 radially inner cylindrical portion with an inner surface  
23 adapted to be press fitted on a rotatable shaft and an  
24 outer surface engaged by both said lips and having a  
25 larger outer diameter than the inner diameter of said lips  
26 before assembly with said wear sleeve member, so that  
27 assembly of the wear sleeve on the seal member causes  
28 further spreading-apart of said two lips, the end wall of  
29 said dirt-excluding lip, when said lip is in position on  
30 said wear sleeve being substantially perpendicular to said  
31 wear sleeve's outer surface,

32       said wear sleeve member also having a flange  
33 portion extending radially outwardly from the air side end  
34 of the wear sleeve's cylindrical portion and an intumed  
35 portion at an angle to said radial flange and extending  
36 axially toward said case's radial flange and having an  
37 outer end spaced radially inwardly from the outer gener-

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1 ally cylindrical portion of said elastomeric member but  
2 extending radially outwardly beyond the radially inner  
3 extremities of said retaining portions, so that the  
4 inturned portion of said wear sleeve member can be snapped  
5 into the space between said retaining portions and said  
6 radial flange of said metal case.

7

8 8. The grease seal of claim 7 wherein said wear  
9 sleeve's flange has a truly radial portion where it meets  
10 said cylindrical wear sleeve portion, extending beyond  
11 said end wall of said dirt-excluding lip followed by an  
12 angularly extending portion, going toward said case's  
13 radial flange and ending at its radially outermost,  
14 axially innermost point.

15

16 9. The grease seal of claim 7 wherein said wear  
17 sleeve's flange has a truly radial portion where it meets  
18 the wear sleeve's cylindrical portion, extending beyond  
19 said dirt-excluding lip, followed by an axially inwardly  
20 extending portion going toward said case's radial flange,  
21 followed by a radially extending portion parallel to said  
22 case's radial flange and extending out radially beyond  
23 said retaining portions, followed by an axially outwardly  
24 and radially inwardly extending angular portion ending  
25 substantially flush axially with the end of said bore-  
26 sealing portion and radially within said retainer  
27 portions.

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29 10. The grease seal of claim 7 wherein said  
30 cylindrical outer portion is stepped and said elastomeric  
31 member has a portion extending from said outer generally  
32 cylindrical portion to the outer surface of said wall and  
33 bonded thereto to provide a bore-engaging outer  
34 periphery.

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1           11. A grease seal member, including in  
2 combination:

3           a one-piece metal case with a cylindrical bore-  
4 sealing portion and an inwardly extending radial flange  
5 having a radially inner end,

6           a molded elastomeric member bonded to said metal  
7 case and having an inner portion extending radially  
8 inwardly of said radial flange and having two diverging  
9 lip portions, meeting, as molded, at about 90° at a point  
10 in line with said flange and with a cavity between them,  
11 one said lip portion providing a grease-retention lip  
12 having spaced-apart small relieved indentations enabling  
13 passage of small amounts of grease into said cavity, the  
14 other said lip portion having a polytetrafluoroethylene  
15 insert bonded to said elastomeric member and providing the  
16 sealing edge portion of a dirt-excluding lip.

17

18           12. The sealing member of claim 11 wherein said  
19 dirt excluding lip has an air-side end wall, which upon  
20 installation of said sealing member on a contacting  
21 surface for sealing therewith, with further spreading-  
22 apart of said two lips, becomes substantially perpendicu-  
23 lar to said contacting surface.

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25           13. A method for making a unitized dual-lip shaft  
26 seal for sealing in grease and sealing out dirt and other  
27 foreign matter, with one lip having a polytetrafluoro-  
28 ethylene insert sealing member, comprising:

29           seating on a first mold member a one-piece metal  
30 case, while seating the case's outer bore-engaging cylin-  
31 drical portion against a second mold member, the case  
32 having an axially inset radial flange with an air-facing  
33 side and a grease-facing side, appropriate parts of said  
34 case being covered with elastomer-bonding cement,

35           engaging a third mold member with said first mold  
36 member so as to define between them a cavity for molding  
37 to finished size and shape a grease-facing lip at an

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1 angle of about 45° to said radial flange, and also provid-  
2 ing one surface of another cavity for an air-facing lip,  
3 sloping in the opposite direction at an angle of about 45°  
4 to said radial flange, so that the two cavities meet at  
5 about 90° to each other, said surface leading to a ledge  
6 spaced away from said radial flange and parallel to the  
7 plane thereof, said ledge ending at an inner cylindrical  
8 boundary,

9 placing a flat washer of polytetrafluoroethylene  
10 on said ledge with an inner circumference of said washer  
11 engaging said boundary and an outer circumference extend-  
12 ing beyond said ledge and overhanging a portion only of  
13 said sloping surface, with appropriate surface portions of  
14 said washer being treated to enhance bonding of elastomer  
15 thereto,

16 positioning a ring of uncured elastomer on top of  
17 the portion of said washer supported by said ledge,

18 bringing a fourth mold member toward and against  
19 said second and third mold members, while all said mold  
20 members are heated to a molding and curing temperature, so  
21 as to define the remainder of the mold cavity for the  
22 air-facing lip and to define a further cavity having a  
23 radial portion next to said radial flange and an outer  
24 cylindrical portion next to the cylindrical portion of  
25 said case and shaped to provide a set of circumferentially  
26 spaced-apart cavity portions extending radially inwardly  
27 to provide retention members, all while forcing said  
28 elastomer to flow into all the mold cavities and also to  
29 flex the overhanging portion of said washer into engage-  
30 ment with said sloping surface and to initiate bonding of  
31 the elastomer to said case and said washer,

32 curing said elastomer to a desired amount so that  
33 it holds its shape and completes the bonding to said case  
34 and said washer, to produce a shaft sealing member with a  
35 grease-facing lip molded to its final shape and an air-

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1 facing lip having a portion extending generally inwardly  
2 therefrom, said shaft sealing member also having a set of  
3 retention members spaced away from said radial flange,  
4 then opening said mold and removing said shaft  
5 sealing member,

6 trimming said air-facing lip to a desired length  
7 at a trimmed edge having a desired angle so that, when the  
8 product is unitized, the trimmed edge is nearly parallel  
9 to said radial flange,

10 forming a one-piece metal wear sleeve having a  
11 cylindrical portion for engagement with both said lips and  
12 of a size to force spreading apart of those lips and, as a  
13 result, moving the trimmed edge to its said nearly-  
14 parallel position, said wear sleeve also having a radially  
15 outwardly extending portion of a size enabling  
16 unitization,

17 assembling said wear sleeve and shaft sealing  
18 member together, with the sleeve's radially outwardly  
19 extending portion on the grease side of said shaft sealing  
20 member, the lips being in engagement with the cylindrical  
21 portion of said wear sleeve, and

22 snapping the radially outwardly extending portion  
23 into the space between said retention members and said  
24 elastomer-covered radial flange, said retention members  
25 thereafter hindering retraction of the wear sleeve from  
26 said shaft-sealing member.

27

28 14. A method for making a dual-lip shaft seal for  
29 sealing in grease and sealing out dirt and other foreign  
30 matter, with one lip having a polytetrafluoroethylene  
31 insert sealing member, comprising:

32 seating on a first mold member a one-piece metal  
33 case, while seating the case's outer bore-engaging cylin-  
34 drical portion against a second mold member, the case  
35 having a radial flange with an air-facing side and a  
36 grease-facing side, appropriate parts of said case being  
37 covered with elastomer-bonding cement,

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1           engaging a third mold member with said first mold  
2 member so as to define between them a cavity for molding  
3 to finished size and shape a grease-facing lip at an  
4 angle of about  $45^{\circ}$  to said radial flange, and also provid-  
5 ing one surface of another cavity for an air-facing lip,  
6 sloping in the opposite direction at an angle of about  $45^{\circ}$   
7 to said radial flange, so that the two cavities meet at  
8 about  $90^{\circ}$  to each other said surface leading to a ledge  
9 spaced away from said radial flange and parallel to the  
10 plane thereof, said ledge ending at an inner cylindrical  
11 boundary,

12           placing a flat washer of polytetrafluoroethylene  
13 on said ledge with an inner circumference of said washer  
14 engaging said boundary and an outer circumference extend-  
15 ing beyond said ledge and overhanging a portion only of  
16 said sloping surface, with appropriate surface portions of  
17 said washer being treated to enhance bonding of elastomer  
18 thereto,

19           positioning a ring of uncured elastomer on top of  
20 the portion of said washer supported by said ledge,

21           bringing a fourth mold member toward and against  
22 said second and third mold member, while all said mold  
23 members are heated to a molding and curing temperature, so  
24 as to define the remainder of the mold cavity for the  
25 air-facing lip, all while forcing said elastomer to flow  
26 into all the mold cavities and also to flex the overhang-  
27 ing portion of said washer into engagement with said  
28 sloping surface and to initiate bonding of the elastomer  
29 to said case and said washer,

30           curing said elastomer to a desired amount so that  
31 it holds its shape and completes the bonding to said case  
32 and said washer, to produce a shaft sealing member with a  
33 grease-facing lip molded to its final shape and an air  
34 facing lip having a portion extending generally inwardly  
35 therefrom,

36           then opening said mold and removing said shaft  
37 sealing member, and

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1           trimming said air-facing lip to a desired length.  
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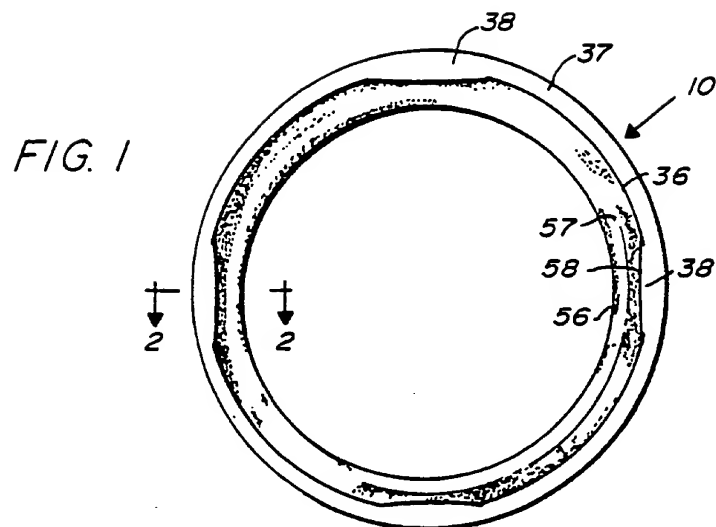


FIG. 2

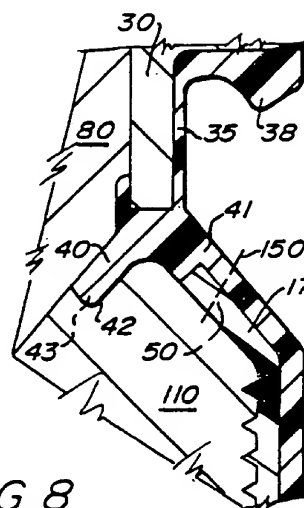
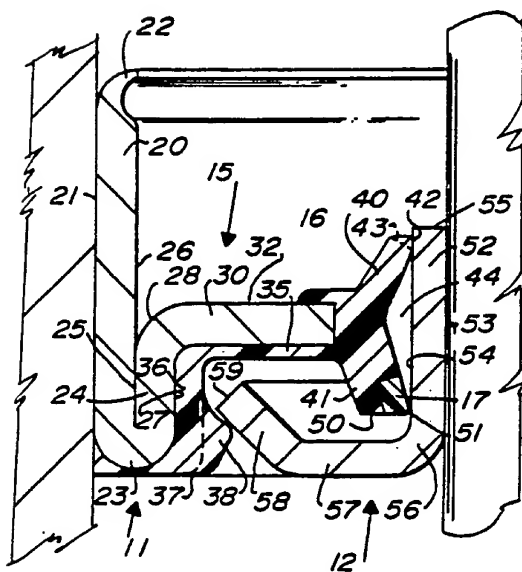
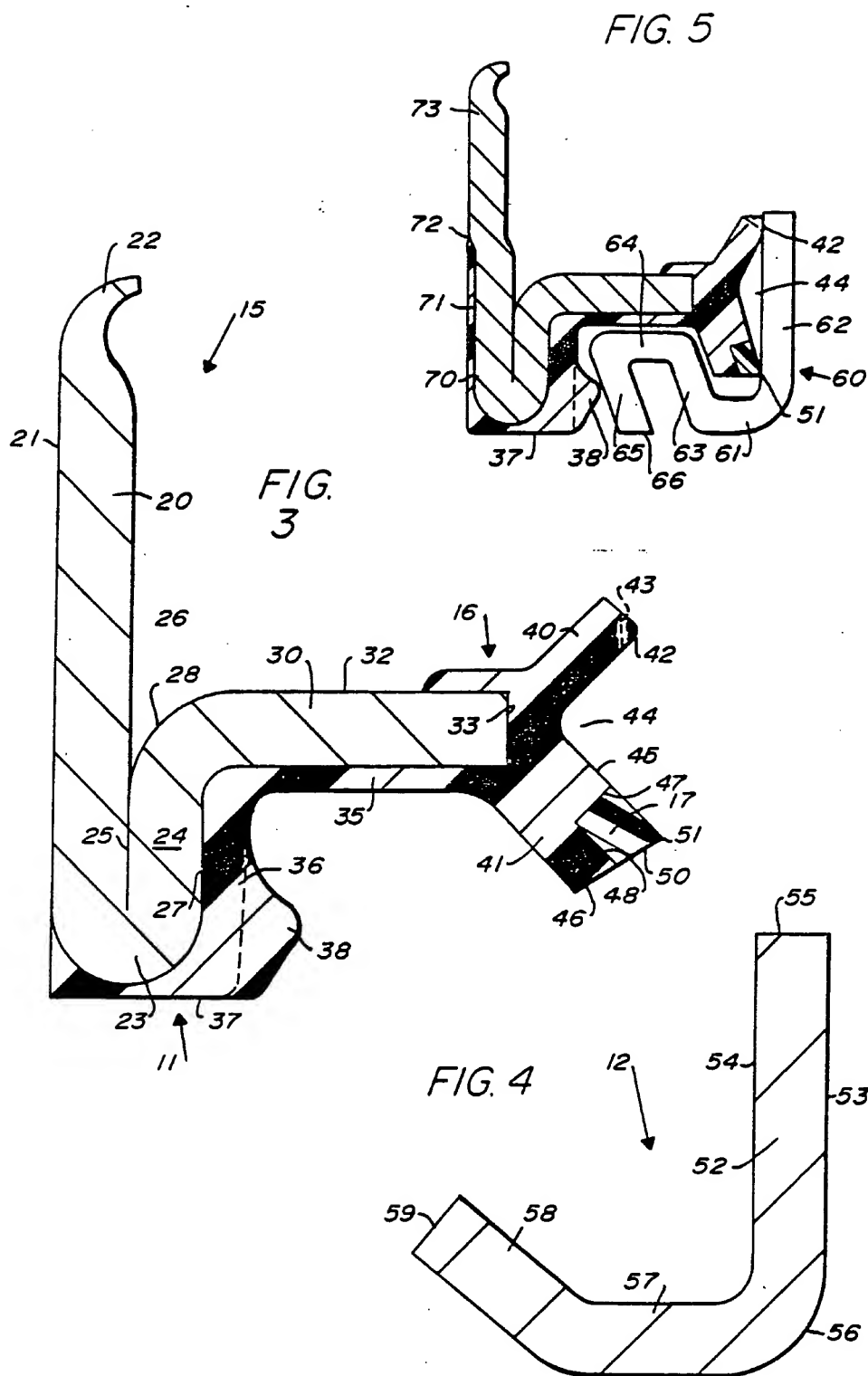


FIG. 8



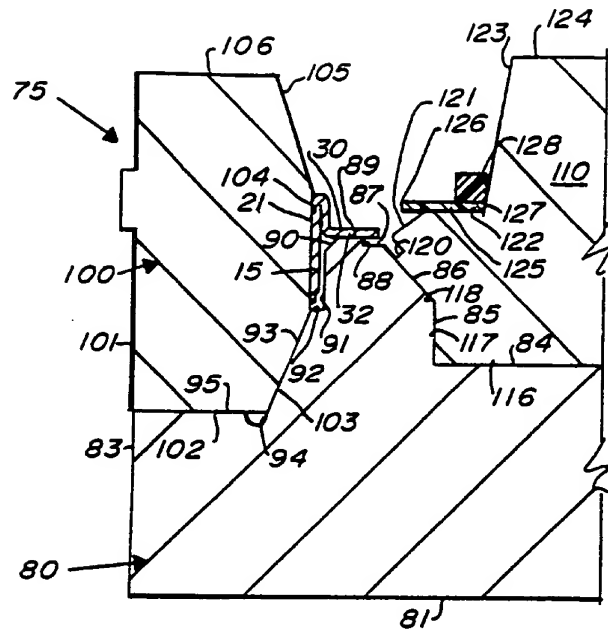


FIG.  
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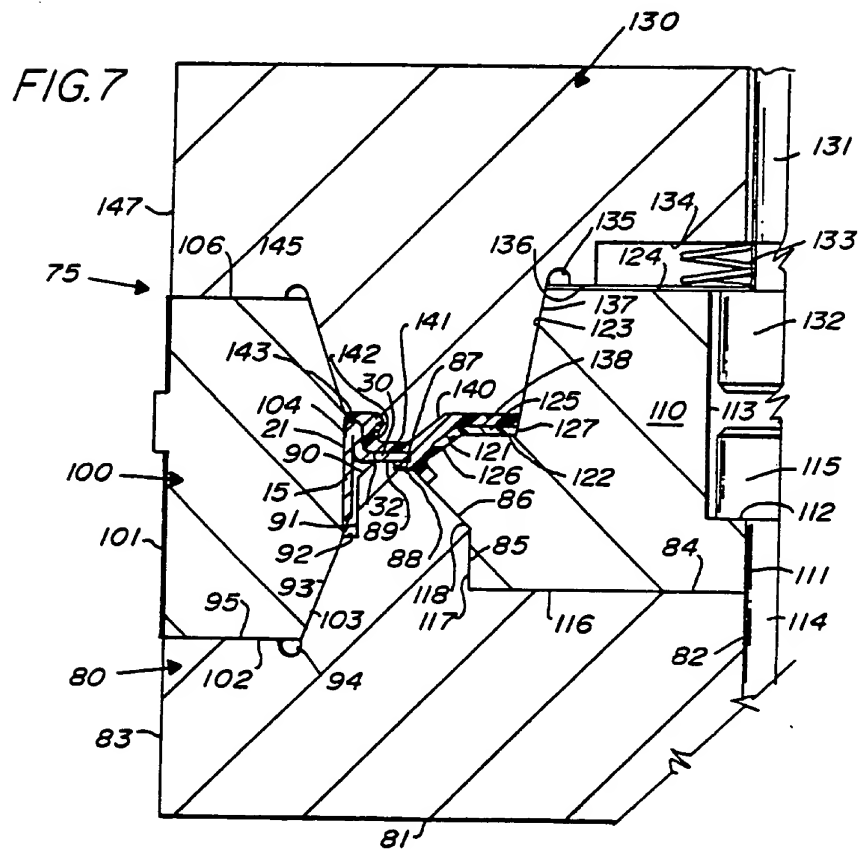


FIG.7



# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 85/00188

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>4</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC<sup>4</sup>: F 16 J 15/32

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>7</sup>

Classification System

Classification Symbols

IPC<sup>4</sup>

F 16 J

Documentation Searched other than Minimum Documentation  
to the extent that such Documents are Included in the Fields Searched <sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup>

Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	FR, A, 2430555 (IAO) 1 February 1980 see page 1, line 37 - page 2, line 30; claim 1; figure 1 --	1,2,4,8
Y	FR, A, 2296800 (GOETZEWERKE) 30 July 1976 see page 3, line 29 - page 4, line 15; figures 1,3,4 --	1,4
A	EP, A, 0065887 (SOC. NOUVELLE DE ROULEMENTS) 1 December 1982 see claim 1; figures --	1,2,4,8
A	FR, A, 2373003 (GARLOCK) 30 June 1978 see page 2, line 18 - page 3, line 36; figures 1-3 (cited in the application) --	1,6,11,13,14
A	FR, A, 1508575 (CHROMEX) 5 January 1968 see page 2, left-hand column, paragraph 8 - right-hand column, paragraph 11; figures 1-7 --	1,6,11,13,14 ./.

\* Special categories of cited documents: <sup>10</sup>

"A" document defining the general state of the art which is not  
considered to be of particular relevance

"E" earlier document but published on or after the international  
filing date

"L" document which may throw doubts on priority claim(s) or  
which is cited to establish the publication date of another  
citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or  
other means

"P" document published prior to the international filing date but  
later than the priority date claimed

"T" later document published after the international filing date  
or priority date and not in conflict with the application but  
cited to understand the principle or theory underlying the  
invention

"X" document of particular relevance; the claimed invention  
cannot be considered novel or cannot be considered to  
involve an inventive step

"Y" document of particular relevance; the claimed invention  
cannot be considered to involve an inventive step when the  
document is combined with one or more other such docu-  
ments, such combination being obvious to a person skilled  
in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

10th May 1985

Date of Mailing of this International Search Report

10 JUIN 1985

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

G.L.M. Kruidenberg

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	FR, A, 2238875 (SIMMERWERKE) 21 February 1975 see page 2, lines 19-36; figure 1 --	1,6,11,13, 14
A	US, A, 3955859 (STELLA) 11 May 1976 see column 1, line 62 - column 2, line 43; figure 1 --	1,5,11
A	DE, C, 815283 (KUPFER-ASBEST) 2 August 1951 see page 2, lines 19-42; figures -----	10

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 8500188 (SA 8862)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 04/06/85

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2430555	01/02/80	DE-A- 2926207 GB-A- 2030236	17/01/80 02/04/80
FR-A- 2296800	30/07/76	DE-A,B,C 2500099 GB-A- 1523310 DE-A,B,C 2533751	08/07/76 31/08/78 10/02/77
EP-A- 0065887	01/12/82	FR-A,B 2505951 US-A- 4434985	19/11/82 06/03/84
FR-A- 2373003	30/06/78	DE-A- 2753170 US-A- 4171561 GB-A- 1578897 CA-A- 1120071	08/06/78 23/10/79 12/11/80 16/03/82
FR-A- 1508575		None	
FR-A- 2238875	21/02/75	DE-A- 2435675 AT-A,B 328815 SE-A- 7409615	13/02/75 12/04/76 27/01/75
US-A- 3955859	11/05/76	None	
DE-C- 815283		None	

For more details about this annex :  
see Official Journal of the European Patent Office, No. 12/82